

DRAFT

Marine Mammal Monitoring and Mitigation Measures

2006 Seismic Acquisition Program

Beaufort Sea and Chukchi Sea

Offshore Alaska

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INTRODUCTION

This document contains the proposed marine mammal monitoring and mitigation measures for seismic acquisition operations in the Beaufort Sea and Chukchi Sea in the open water season of 2006. The purpose of the monitoring and mitigation is to:

- Provide real-time or near real-time feedback to the operator to allow adjustments to the survey so that the potential impacts on marine mammals, especially bowhead whales, can be minimized, and
- Collect reliable field data to determine if the overall survey may have caused an impact on the whale population, or subsistence harvesting activities. Data derived from field observations will be utilized, in part, to support the development of estimates of marine mammal takes either by physical injury or behavioral disturbance. Estimates of take and other marine mammal observations will be reported to the U.S. Minerals Management Service (MMS) and National Marine Fisheries Service (NMFS).

Guidelines for the conduct of seismic operations in areas where marine mammals have the potential for occurrence have been developed for some countries or jurisdictions, and these examples have been used to aid in the development of project-specific measures for the proposed seismic survey program. The most comprehensive sets of guidelines have been developed for the following areas:

- United Kingdom Continental Shelf waters, by the Joint Nature Conservation Committee (JNCC, 1998). The JNCC guidelines apply to both cetaceans and pinnipeds, but emphasise cetaceans.
- Southern California waters, by the High Energy Seismic Survey (HESS) Team; apply to cetaceans, pinnipeds, and (in part) sea otters (HESS, 1999).
- Australian waters, by Environment Australia and the Australian Petroleum Production and Exploration Association (APPEA). These apply to cetaceans only, not pinnipeds (Environment Australia, 2001).
- MMS (2004) mitigation measures for seismic surveys in the Gulf of Mexico. These measures also apply to deep water (>200 m), sperm whales, and sea turtles.
- Recent seismic surveys in the Beaufort Sea, north of Alaska, have also been subject to intensive regulatory action, and have included extensive monitoring and mitigation requirements. No specific list of guidelines or requirements has been published for this area, but de facto requirements concerning both cetaceans and pinnipeds have generally evolved (NMFS, 1999, 2000a and Lawson, 2002).

Certain other countries or jurisdictions have also adopted various guidelines and practices, but for the most part, these generally represent variations on the five sets of guidelines outlined above Appendix.

There have been a number of seismic surveys carried out in the waters of the Beaufort Sea. A key issue for surveys carried out during the open water season in the Beaufort Sea is the potential for impacts to occur to bowhead whales in their summer feeding areas and, most importantly, during fall migratory movements when they are hunted by Inupiat subsistence hunters. The mitigation measures and monitoring program discussed in this document focuses primarily on reducing potential adverse impacts on bowhead whales. Table 1 summarizes the proposed measures for the seismic acquisition program.

Mitigation or Monitoring Category	Proposed Measures
Seasonal Restrictions	<ul style="list-style-type: none"> • The seismic survey needs to be conducted during the open-water season, i.e. between May and November. Operations will be conducted in the Chukchi Sea between May and August & between September and November and in the Beaufort Sea between August and October All practicable measures will be taken to complete seismic operations in the Beaufort Sea as early as possible and to vacate areas within proximity of subsistence bowhead hunting prior to initiation of hunting activities and until such a time as these communities have acquired at least two bowhead whales, or ceased hunting activities. • Given the potential for deflection offshore, re-initiation of seismic operations within areas of the Beaufort will occur only in cases where hunting activities are agreed to be remote from seismic operations or when the affected villages have acquired at least two whales or ceased hunting activities.
Aerial Surveys	<ul style="list-style-type: none"> • Aerial surveys will be conducted of the regional distribution and abundance of the whales in 2006 during seismic survey operations and up until 3 days after the survey.
Airgun Array Size/Configuration	<ul style="list-style-type: none"> • The airgun array will be configured to maximise the proportion of the energy that is directed downward and to minimise horizontal sound propagation. The size of the airgun arrays, as measured by the source level, will not be any larger than required to meet the technical objectives for the seismic survey. • Pre-Mobilization modelling, based upon anticipated sound propagation characteristics of the array, will be utilized to establish anticipated impact zones of 180 dB and 190 dB. • At the initiation of the field season, field sound propagation assessments will be conducted and 180 dB and 190 dB zones adjusted accordingly.
Ramp-up or Soft Start	<ul style="list-style-type: none"> • The seismic operator will ramp-up airguns slowly over a period of 20 minutes each time shooting begins, especially if the shut-down period has been substantial, i.e. over 10 minutes. 'Soft starts' will follow every interruption of the survey, most importantly if the survey is discontinued until marine mammals leave the safety zone. The seismic operator and on-board environmental monitors (see below) will maintain records of the times when ramp-ups start, and when the airgun array reaches full power. • During periods of transit between seismic transects, one airgun will remain operational. Through the use of this approach, seismic operations can resume upon entry to a new transect without full ramp up. • If shut down occurs, ramp up will begin only following a half hour period of observation of the exclusion zone to assure that no marine mammals are present. Ramp up procedures are followed until full operating intensity is achieved.

Safety Distance	<ul style="list-style-type: none"> Initial safety zones will be established prior to the survey based on available data and modelling concerning sound output and on the assumption that seismic pulses at broadband received levels above 190 dB re 1 μPa (rms over duration of pulse) for pinnipeds, or above 180 dB re 1 μPa rms for cetaceans. These levels should be avoided whenever possible because they might affect hearing abilities at least temporarily. The safety radii for pinnipeds and cetaceans at these two respective received levels (190 and 180 dB) are expected to be in the order of 250 m and 1 km, respectively. The safety distances will be verified (and if necessary adjusted) during the first week of the seismic survey, based on direct measurements via calibrated hydrophones of the received levels of underwater sound versus distance and direction from the airgun array.
Shipboard Marine Mammal Observers	<ul style="list-style-type: none"> One or more trained marine mammal observers on the seismic ship will be on watch for marine mammals during all daylight hours when seismic operations are in progress and a minimum of ½ hour prior to the initiation of airgun operation.
Operations at Night or in Poor Visibility	<ul style="list-style-type: none"> Seismic activities will not be initiated from a cold start up during darkness or during conditions when visibility is reduced to less than the radius of the safety zone. Seismic operations may continue under conditions of darkness or reduced visibility as long as at least one gun is kept operational at all times to warn marine mammals from the area. Operations may, however, be required to be shut down during periods of limited visibility if, in the judgement of the senior marine mammal observer, densities of marine mammals in the general area are high enough to warrant concern that a marine mammal is likely to enter the safety zone undetected. When operating under conditions of reduced visibility attributable to darkness or to adverse weather conditions, infra-red or night-vision binoculars will be available for use by shipboard mammal observers
Real time Acoustic Monitoring	<ul style="list-style-type: none"> Not Recommended.
Other Mitigations Associated with Routine Vessel & Aircraft Operation	<ul style="list-style-type: none"> A variety of standard mitigation measures related to vessel and aircraft operation environmental impacts (discharges to water, emissions to air, waste management, etc.) have been captured in details in the later sections of this document. These measures are typically defined to ensure compliance with applicable laws and regulations.
Control of Accidental Spills, Leaks & Dropped Objects	<ul style="list-style-type: none"> The seismic vessel will have an emergency contingency plan that is robust enough to allow adequate response to potential spills, leaks, and objects that could be dropped from the vessel.

Table 1 – Summary of Mitigation and Monitoring Measures for 2006 Seismic Acquisition

The sections following Table 1 describe in more detail the major categories of mitigation and monitoring recommendations contained in one or more of the above sets of guidelines. For each category, there is a description of the corresponding mitigation measure that will be implemented during the seismic survey.

OPERATIONAL MITIGATIONS ASSOCIATED WITH SEISMIC DATA ACQUISITION

SEASONAL RESTRICTIONS

Background

It is standard practice in many areas to conduct seismic surveys at times of year when marine mammals are absent, present in relatively small numbers, or present, but not engaged in sensitive activities such as breeding or feeding. In the Alaskan Beaufort Sea, however, seismic surveys are feasible only during limited periods of open water, which overlap with periods when bowhead whales and other marine mammals may be within the project area. The most important period of this open water season to avoid, however, is portions of the fall migration of the bowhead whale. During this portion of late summer and early fall the members of the Inupiat communities hunt within areas offshore of Kaktovik, Cross Island, and Barrow and as far as 30 miles from shore. The western migration of bowheads generally begins around the middle of August, with an initial pulse of movement followed by a "main pulse" in late September to early October. A final "late pulse" occurs in late October, the end coinciding with the formation of ice coverage. Associated with the onset of migration, subsistence hunts begin around September 1.

Both the results of previous monitoring programs and observations made by Inupiat whale hunters indicate that seismic operations have the potential to impact bowhead distribution and movement patterns. A study conducted by LGL in 1998 (Richardson, 1999) indicated that bowheads are rarely observed within 20 km of seismic operations and may show a degree of avoidance to a distance of 30 km from operations. Although this "avoidance" of areas of seismic operation has been shown to disappear after 12 hours, i.e. bowheads re-occupy areas vacated by avoidance, deflections around areas of operation seem to occur at distances of 19 – 21 km to the northeast and to persist for at least 40 – 50 km to the west of operations. It is not known whether whales deflected offshore by seismic operations return to nearer shore as they progress along the coast. Further, traditional knowledge of Inupiat whalers indicate that deflections may reach as much as 35 miles and may persist long after the whales have passed the source of sound.

Proposed Measures

For the proposed seismic survey, a mitigation measure pertaining to seasonal timing will be implemented in line with the above international practices:

- The seismic survey needs to be conducted during the open-water season, *i.e.* between May and November. Operations will be conducted between July and August and between September and November in the Chukchi Sea and between August and October in the Beaufort Sea.
- All practicable measures will be taken to complete seismic operations as early as possible and to vacate areas within close proximity of subsistence bowhead hunting areas during

periods of hunting activity. During periods of hunting activity, seismic operations will be moved to areas remote from hunting operations or ceased for a period.

- From August 15 until the end of the bowhead hunting season (or until the end of seismic operations) special monitoring and mitigation/mitigation measures will be adopted, i.e. aerial surveys.
- Given the potential for diversion offshore, re-initiation of seismic operations within identified hunting areas will proceed only after the village has acquired at least two whales or ceased hunting activities and only with close coordination with representatives of the whaling captains. All reasonable efforts will be made to avoid disruption of the hunt or deflection of migrating bowheads in hunting areas.

Aerial Surveys

Background

The marine mammal protection measures commonly used in seismic operations in the Alaskan Beaufort Sea, indicate that aerial surveys should be conducted as a part of the marine mammal monitoring program, with surveys conducted daily (weather permitting) during the period when the bowhead whale migration/hunt is underway. Surveys should be conducted bi-weekly from the middle to the end of August, and daily (when possible) after September 1st. Aerial surveys are to continue for at least three days after the cessation of seismic operations.

Aerial surveys are typically conducted by teams of four observers (a pilot, two dedicated observers, and an observer/data recorder) in twin-engine airplanes. Observations are made at an altitude of 900 to 1,500 feet and a groundspeed of 120 knots. The survey plane traverses a survey grid, centered on the seismic operations, which extends 50 to 75 km both east and west of the seismic operations and to 75 km offshore. Periodic flights that range further to the east may be utilized prior to the onset of migration to provide an early warning of the approach of migrating bowhead whales.

Data derived from the aerial surveys can be utilized to provide regular updates to seismic operations as to the presence of marine mammals within or approaching the operational area. The data would also be used for evaluating the extent and impact of operations on marine mammals.

Proposed Measures

For the proposed seismic survey, the following measures are planned:

- Aerial surveys of the regional distribution and abundance of marine mammals with special attention to bowhead whales in 2006 prior to the initiation of the seismic survey starts and periodically during and after the survey. The objectives are to:

- Provide real-time or near real-time information that can be used (if appropriate) to alter the survey's starting point and survey line sequence based on the actual distribution of whales in the area immediately prior to and during surveys (see below),
 - Document the numbers of whales exposed to seismic surveys and their responses to the surveys, and
 - Conducted aerial surveys only when they can be carried out in a safe manner and during periods of good visibility where there is sufficient probability of detecting bowhead whales and other marine mammals.
- Beginning at least three days prior to the beginning of seismic surveys, aerial surveys will be conducted on a daily basis, when practicable given weather and visibility conditions.
 - Aerial surveys conducted during the bowhead whaling season will be coordinated with whaling efforts, such that airplanes operating in close proximity to whalers can take action, e.g. flying at higher altitudes, to reduce the potential to impact the hunt
 - Generally, the flight plan and coverage of the aerial survey will be conducted following established standards and methodologies, as described above, with particular reference to MMS Bowhead Whale Aerial Survey Program procedures. Specific details of the flight pattern and coverage will be fully developed in an aerial flight operations plan but will be subject to operation changes as needed to provide effective coverage during field operations.

AIRGUN ARRAY SIZE AND CONFIGURATION

Background

Increasing attention is being given in some jurisdictions to the desirability of:

- Avoiding unnecessarily strong energy sources,
- Minimizing the proportion of the energy that propagates horizontally, and
- Minimizing the amount of energy at frequencies above those useful for geophysical purposes.

In the Alaskan Beaufort Sea, where disturbance to bowhead whales is a major issue, seismic surveys conducted since 1996 have been done with relatively small arrays of airguns in part to minimise impacts on bowhead whales. Two different seismic contractors have also each reduced the size of their standard airgun array after their first year of operations. It should be noted that a small, closely-spaced array of airguns was used for only one season because it was found to emit more sound in horizontal directions than did other larger arrays that were designed to reduce horizontal propagation (Balla-Holden *et al.*, 1998 and Lawson, 2000).

Recent practices in the Beaufort Sea area, as well as SEIC practices, have included the use of field measurements of sound, and have been used to determine the characteristics and levels of the airgun pulses and vessel sounds at varying distances and the propagation characteristics of the study area. Hydrophones are deployed from a stationary vessel, or are deployed at a number of stations, and record sounds from the airgun array and operating vessels.

Data from this effort are utilized in the projection of potential impact areas. Whereas NOAA Marine Fisheries (NMFs) criteria for seismic operations in the Gulf of Mexico require an established exclusion zone of 500 m, recent practices in the Beaufort have established the exclusion zone on the basis of the projected 180 dB range for cetaceans and 190 dB for pinnipeds. While these zones projected prior to measurement for 1998 Western Geophysical operations in the Beaufort were 170 m (190 dB zone) and 660 m (180 dB zone) for the vessel *Saber Tooth*, field measures of 524 m (190 dB zone) and 1524 m (180 dB zone) resulted in an increase of the exclusion zones.

Modelling of the likely extent of sound propagation will be conducted to establish recommended exclusion zones prior to entry into the field. A period of 1 to 3 days will be required at the beginning of the season to conduct source characterization operations, with the realization that the results of this process may alter the exclusion zones.

Proposed Measures

For the proposed seismic survey:

- The airgun array will be configured to maximise the proportion of the energy that is directed downward and to minimise horizontal sound propagation. In particular, closely spaced airguns whose overall radiation pattern is nearly omni-directional will be avoided. The size of the airgun arrays, as measured by the source level, will not be any larger than required to meet the technical objectives for the seismic survey.
- Pre-initiation modelling, based upon anticipated sound propagation characteristics of the array, will be utilized to establish anticipated impact zones of 180 dB and 190 dB.
- At the initiation of the field season, field sound propagation assessments will be conducted and 180 dB and 190 dB zones adjusted accordingly.

RAMP-UP OR SOFT START

Background

It has become standard practice to increase the source level of an airgun array gradually after a period when the airguns have been silent, rather than to commence firing all airguns simultaneously at full power. This practice is intended to allow any marine mammals that are close to the array to move away, if they find the airgun sounds to be distasteful, before they

are exposed to the sounds at full power. The measure is primarily intended to reduce any potential for hearing damage.

The soft start procedure involves a gradual increase in the number of airguns fired over a 20 minute period prior to commencement of a survey line, and serves to send out a series of warning pulses to whales and give them adequate time to leave the vicinity.

The MMS guidelines for the Gulf of Mexico require 'soft start' procedures for all seismic surveys in water depths greater than 200 m and operations in OCS water depths less than 200 meters (656 ft.) in the Eastern Planning Area of the Gulf of Mexico. Specifically, the guidelines state the following monitoring requirements:

- "Visually monitor the exclusion zone and adjacent waters for the absence of sperm whales for at least 30 minutes before initiating ramp-up procedures. If no sperm whales are detected, you may initiate ramp-up procedures. You must not initiate ramp-up procedures at night or when you cannot visually monitor the exclusion zone for sperm whales if your minimum source sound level output drops below 160 dB re 1 μ Pa (see measure 5).
- Initiate ramp-up procedures by firing a single airgun. The preferred airgun to begin with should be the smallest airgun, in terms of energy output (dB) and volume (in^3).
- Continue ramp-up by activating additional airguns at a rate of 6 dB re 1 μ Pa per 5 minute interval until the airgun array is operating at the desired survey intensity.
- Immediately shut down all airguns ceasing seismic operations at any time a sperm whale is detected entering or within the exclusion zone. You may recommence seismic operations and ramp-up of airguns only when the exclusion zone has been visually inspected for at least 30 minutes for the absence of sperm whales.
- You may reduce the energy output of the airgun array to maintain a minimum source sound level output of 160 dB re 1 μ Pa for routine activities, such as making a turn between line transects, or for maintenance needs. This procedure may be followed during periods of impaired visibility (e.g., darkness, fog, high sea states, etc.) and does not require a 30 minute visual clearance of the exclusion zone before the airgun array is again ramped up to full output."

In the Alaskan Beaufort Sea, program ramp up is both a standard operating procedure and standard requirement for seismic operations within areas utilized by marine mammals. Ramp up includes pre-initiation observation for a minimum period of one half hour with no reports of marine mammals within the exclusion zones. Upon initiation, the sound level is begun at a low level through the utilization of a single airgun, that being the smallest available. Additional guns are added incrementally over a period of up to one half hour, until full operational intensity is achieved.

The ramp up procedures allow marine mammals within proximity of the array to move out of the area prior to the initiation of potentially deleterious intensity levels.

Proposed Measures

For the proposed seismic survey, the following 'soft start' procedures are planned:

- The seismic operator will ramp-up airguns slowly over a period of 20 minutes each time shooting begins, especially if the shut-down period has been substantial, *i.e.* over 10 minutes. 'Soft starts' will follow every interruption of the survey, most importantly if the survey is discontinued until marine mammals leave the safety zone. The seismic operator and MMOs will maintain records of the times when ramp-ups start, and when the airgun array reaches full power.
- During periods of turn around and transit between seismic transects, one airgun will remain operational. Through use of this approach, seismic operations can resume upon entry to a new transect without full ramp up. While it is routine to ramp up from a single gun firing to full array operation, operation of a single gun allows starting during poor visibility and ramp up without a period of static visual observation.
- If shut down occurs, ramp up will begin only following a minimum of a one half hour period of observation of the exclusion zone to assure that no marine mammals are present. Ramp up procedures will be followed until full operating intensity is achieved.

SAFETY DISTANCE

Background

Internationally the various guidelines and practices differ substantially with regard to the recommended or required action when marine mammals are seen within designated distances or within zones where the airgun sounds might exceed some specified received level.

The MMS guidelines for the Gulf of Mexico call for the onset of airgun operations to be delayed if a sperm whale is seen within a 500 m radius surrounding the centre of an airgun array and the area within the immediate vicinity of the survey vessel during the 30-minute period before operations are expected to commence. Airgun operations are also to be suspended if a sperm whale is seen within this exclusion zone during airgun operations. 'Soft start' and seismic survey activities can only be resumed when the observer has:

- Determined that the sperm whale(s) has departed the exclusion zone;
- Visually monitored the exclusion zone for at least 30 minutes since the last sperm whale sighting within the exclusion zone.

In the Alaskan Beaufort Sea, impact and exclusion zones have been established through the modelling of sound intensity and propagation on the basis of the specific equipment being utilized. Further work should be provided to field test, verify, and adjust for actual field conditions.

NMFS (National Marine Fisheries Service) recognizes exclusion zones (areas within which sound intensity has the potential to produce lasting injury to marine mammals) and impact zones (areas within which harassment may produce behavioral reactions to the sound source), and has established sound intensity based criteria for exclusion zones, being 180 dB for cetaceans and 190 dB for pinnipeds. These criteria are currently under review. Exclusion zones are based on sound intensity criteria, rather than prescribed distances.

The approach has been similar to that developed for the 1996 to 2000 Alaskan Beaufort Sea survey. The 190, 180, and 160 dB distances are estimated in advance based on:

- Characteristics of the planned airgun array;
- Existing site-specific propagation data;
- Measurements of received levels versus distance from airgun arrays operating in the same general area in previous years.

The predictions are checked by direct field measurements during the first 7 to 10 days of the seismic program, and adjustments to the safety radii are made as necessary. No acoustical measurements have been required in years when the airgun array was the same as (or smaller than) an array used and measured in the same area during a previous year.

As noted above, the purpose of the 180 dB guideline for whales is to avoid potentially harmful exposure levels. It has been demonstrated that the behavior of whales can be affected at lower received sound intensities than those causing temporary hearing loss or other physical damage (Richardson et al., 1995).

Proposed Measures

For the proposed seismic survey, the following measures are planned:

- Initial safety zones will be established prior to the survey based on available data and modelling concerning sound output and on the assumption that seismic pulses at broadband received levels above 190 dB re 1 μ Pa (rms over duration of pulse) for pinnipeds, or above 180 dB re 1 μ Pa rms for cetaceans, should be avoided whenever possible because those levels might affect hearing abilities at least temporarily. The safety radii for pinnipeds and cetaceans at these two respective received levels (190 and 180 dB) are expected to be in the order of 250 m and 1 km, respectively. The sound levels are based on frequencies between 10 Hz and 120 Hz, the typical peak spectrum of sound emitted for seismic surveys.
- The safety distances will be verified (and if necessary adjusted) during the first week of the seismic survey, based on direct measurements via calibrated hydrophones of the received levels of underwater sound versus distance and direction from the airgun array. The acoustic data will be analyzed as quickly as reasonably practicable in the field and used to

adjust safety distance. The same acoustic data will be useful in interpreting observations of marine mammals during analysis of sighting data after the programs completion (see below).

SHIPBOARD MARINE MAMMAL OBSERVERS

Background

All of the established international guidelines call for one or more personnel dedicated to marine mammal observations to be stationed aboard the seismic vessel to document the occurrence of marine mammals near the seismic vessel, to help implement mitigation requirements, and to record the reactions of marine mammals to the seismic survey.

The MMS guidelines for the Gulf of Mexico require that seismic operators use trained visual observers on all seismic vessels who have successfully completed a NOAA Fisheries approved training program. The guidelines clearly state that "*seismic operators must shut down the array when instructed by an observer*" but provide few details about observational protocols (*e.g.*, the use of binoculars, maximum length of observation periods). Observers are not required to monitor when atmospheric conditions reduce visibility to zero or during hours of darkness (*i.e.* night). The guidelines state at least two protected species visual observers will be required on watch aboard seismic vessels at all times during daylight hours (dawn to dusk) when seismic operations are being conducted, unless conditions (fog, rain, darkness) make sea surface observations impossible (1) other than brief alerts to bridge personnel of maritime hazards, no additional duties may be assigned to the observer during his/her visual observation watch (2) no observer will be allowed more than 4 consecutive hours on watch as a visual observer, (3) a "break" time of no less than 2 hours must be allowed before an observer begins another visual monitoring watch rotation (break time means no assigned observational duties), and (4) no person (crew or third party) on watch as a visual observer will be assigned a combined watch schedule of more than 12 hours in a 24-hour period.).

During seismic surveys in the Alaskan Beaufort Sea, trained marine mammal observers are required to be on duty, with no other duties, and scanning the area of operations for detection of marine mammals during all operations, unless darkness or weather conditions make such observations impossible. These observers will be stationed at points on the vessel that afford generally unimpeded view of the area of operations, and must have the authority to halt airgun operations any time a marine mammal is observed within, or closely approaching, the established exclusion zone for that species.

In addition to watching for marine mammals during airgun operations, on-board observers should be on duty for at least 30 minutes prior to initiation of ramp up and at other times when vessels are underway with no airgun operations.

In addition to the requirement that these observers be trained and documented, it is also a standard requirement that at least one of the observers be an Inupiat. Duty periods for observers are limited to four-hour stretches, with at least four hours of duty-free time between observation duties. To provide adequate coverage, at least four observers will be required to

provide essentially around the clock observational capability. Two observers will be on duty simultaneously during airgun start up and ramp up.

It is anticipated, on the basis of previous years of monitoring results, that observer initiated shut-downs for bowhead whales will be extremely few. As previously stated, bowhead whales show an avoidance behavior to seismic operations, and are rarely observed within close proximity to operating arrays. Observer initiated shut-downs due to the presence of pinnipeds is, however, more common and is strongly correlated with the amount of ice in the operational area. Pinnipeds do not show strong avoidance behavior, with the result being that shut-downs have ranged as high as 150 during some operations.

Proposed Measures

For the proposed seismic survey, the following measures are planned:

- One or more trained marine mammal observers on the seismic ship will be on watch for marine mammals during all daylight hours when seismic operations are in progress. This will require at least three and preferably four observers on the vessel, given that observer efficiency deteriorates after approximately 4 hours, and that having two observers on watch simultaneously increases the probability of sighting the marine mammals present near the vessel. In selecting seismic vessels for the program, Shell will take account of the requirement to accommodate 3 to 4 marine mammal observers on each vessel.
 - The purpose of the observers on the seismic vessel will be to document the occurrence and responses of marine mammals visible from the vessel, and to initiate airgun shutdown requirements and any other agreed-upon actions when a marine mammal is observed within certain ranges of the sound source. Furthermore, the observers will attempt to confirm the absence of marine mammals in the safety zones prior to 'soft start'.
 - When a marine mammal is sighted within, or approaching, the safety zone around the airgun array, the observers will notify the seismic contractor who will shut down the airguns. After completion of the survey, a technical report and a scientific research paper will be prepared to summarise the observations, results, and conclusions of the marine mammal monitoring program.

OPERATIONS AT NIGHT AND IN POOR VISIBILITY

Background

The JNCC, HESS, Australian, MMS Gulf of Mexico and Alaskan Beaufort Sea guidelines and practices all involve visual observations by observers stationed aboard the seismic vessel and/or support vessels. In all cases, mitigation actions, including delayed start-up and/or airgun shutdown, are to be implemented when marine mammals are sighted within specified distances. Nonetheless, it is recognised that, even on clear nights, visual detection of marine mammals is very difficult and unlikely even when a combination of floodlights, image

intensifiers, and thermal infrared detectors is used. The probability of detecting marine mammals visually deteriorates further in fog, heavy rain, or snowfall, either by day or especially by night.

The MMS guidelines for the Gulf of Mexico do not require monitoring when atmospheric conditions reduce visibility to zero or during the night. However, the guidelines prevent initiation of 'soft start' procedures at night or when poor visibility prevents visual monitoring of the exclusion zone for sperm whales if the minimum source sound level output drops below 160 dB re 1 μ Pa.

In some cases, observers are required to be equipped with night vision capabilities and be on duty during all seismic operations in the Alaskan Beaufort Sea. However, results from such efforts indicate that these measures are not productive. As such, the NMFS has indicated that night vision capability is not a likely requirement to operate in the Beaufort Sea. This position is further supported by the fact that light conditions favorable for marine mammal observations will likely prevail during the majority of the period when seismic operations are conducted.

If shut down occurs for any reason during a period of limited visibility, ramp up can only begin following a half hour period of observation of the exclusion zone can be performed to assure that no marine mammals are present.

Proposed Measures

For the proposed seismic program, the following measures are planned:

- When operating under conditions of reduced visibility attributable to darkness or to adverse weather conditions, infra-red or night-vision binoculars will be available for use. It is recognised, however, that their effectiveness for this application is very limited even in clear night time conditions.
- Seismic activities will not be initiated from a cold start during darkness or during conditions when visibility is reduced to less than the radius of the safety zone. Note that if one small airgun has remained firing, the rest of the array can be ramped up during darkness or in periods of low visibility. Seismic operations may continue under conditions of darkness or reduced visibility unless, in the judgement of the senior marine mammal observer, densities of endangered cetaceans in the general area are high enough to warrant concern that an endangered cetacean is likely to enter the safety zone undetected. In that case, observers will advise the Captain to halt airgun operations, or to move to a part of the survey area where visibility is adequate or where the likelihood of encountering an endangered cetacean is low based on aerial and vessel based surveys that would be part of the real-time monitoring program.

REAL-TIME ACOUSTIC MONITORING

The possibility of using a towed hydrophone array or other passive acoustic technique to detect and perhaps locate marine mammals has been considered for this project, but is not

proposed. Towed hydrophones that are part of the seismic array have the ability to detect marine mammals within close proximity of the array but generally do not provide accurate location information. Hydrophone technology utilizing fixed position hydrophones has been useful in locating bowhead whales through their vocalizations around the fixed BP NorthStar facility (Richardson, 2005), however, the proposed seismic operation will be far ranging and would require either an extensive array of fixed sonobuoys, or multiple "listening" vessels. The presence of "listening" vessels within the seismic project area would add significantly to the number of noise sources present and broaden the potential impact area.

The use of aerial monitoring has demonstrated that bowheads avoid areas where active seismic operations are being conducted and are effective at documenting the extent of this impact. Aerial surveys can also provide early, near-real time, reconnaissance information as to presence or approach of marine mammals to areas of seismic operation. The use of real-time acoustic monitoring would therefore not add significantly to the information available to seismic operators but would add significantly to the complexity and potential area of impact of the project.

Investigatory Monitoring

Background

As the Australian guidelines point out in their recommendations for aerial reconnaissance, "scientific studies to identify which areas are important to cetaceans e.g. to identify feeding, breeding, and resting areas and times of peak migration. In particular these surveys may be required in areas of potential increased sensitivity where insufficient information currently exists to determine timing and appropriate management arrangements. The distribution and behavior of bowhead whales in the Beaufort Sea has been extensively studied by governmental agencies, industry, and independent scientists. Further, and of equal importance, bowheads have been the subject of extensive investigation by native hunters and are a central part of the Alaskan Inupiat culture.

In recent years, investigative programs have been built in to most marine mammal monitoring programs and offshore industrial monitoring programs. Recent investigations by BP-Northstar and by Western Geophysical indicate that migrating bowheads deflect movements from industrial sound sources. This observation is consistent with cultural knowledge, however, more information is needed to ascertain such variables as the extent of deflection resulting from specific sound sources, duration of deflection, and impacts of deflection.

Proposed Measures

SEPCO will develop and implement an investigatory component of its marine mammal monitoring program that is oriented further improving the understanding of deflection related to industrial sound sources, most specifically the operation of seismic acquisition. A detailed study plan is in the process of being developed that will utilize data from aerial surveys, with possible combination with acoustic monitoring.

Operational Mitigations Associated with VESSEL & AIRCRAFT OPERATION

GENERAL SUPPORTING VESSEL & AIRCRAFT MEASURES AND CONTROLS

Support (i.e. supplies, assistance, equipment delivery and personnel transfer) will be provided to the seismic vessel through a combination of direct vessel support and helicopter support. This support adds to the potential for impact to both marine mammals and to subsistence hunting activities. To minimize impacts related to vessel and aircraft support traffic, a number of mitigation measures will be adopted:

Proposed Measures

- Vessels and aircraft will minimize time and distance spent traversing areas outside of the barrier islands. Vessels will, to the extent possible, move along shoreline within the barrier islands, emerging from this route and following the most direct route feasible to the seismic vessel.

Aircraft, including both helicopters and fixed wing survey and spotter planes will attain minimum flight altitudes of at least 1500 feet while over land. They will move along the shoreline while over land, emerging from this route and following the most direct route feasible to the seismic vessel.

- All support vessels will coordinate movements and activities with subsistence hunters, providing detailed plans of movements and regular location updates prior to and during operations.

EFFLUENT DISCHARGES

Impacts associated with routine effluent discharges from the survey program vessels are predicted to be negligible providing the following planned and recommended control measures are adhered to:

- The seismic survey vessel will comply with the requirements of *MARPOL 73/78, Annex I*, and as such:
 - The vessel will have an International Oil Pollution Prevention (IOPP) Certificate;
 - An Oil Record Book (ORB) will be maintained with details of how, when and where any waste oils or oily effluents were disposed of;
 - An oily slops storage tank will be provided;
 - Oily effluents from bilges and machinery spaces will be treated in an oil / water separator to a 15 ppm oil content specification prior to overboard discharge. Bilge will only be pumped if the oil / water separators are functioning correctly;
- Overboard discharges will comply with any other applicable laws and regulations;

- Operational procedures will be in place for the seismic survey vessel for all operations that involve handling fuel, oil and oily effluents/waste during routine and maintenance activities including offshore bunkering/fuelling procedures;
- Sewage generated on the seismic survey vessels will be treated prior to discharge, in compliance with applicable US legislation.

SOLID & SCHEDULED WASTE MANAGEMENT

Provided solid and scheduled wastes generated onboard vessels involved in the survey program are managed and disposed of in accordance with relevant US legal requirements and the engaged survey contractors stated waste management procedures, contamination of the marine environment by waste materials would not be expected.

The following planned and recommended measures will be adhered to:

- All wastes generated will be managed (*i.e.* stored, handled and disposed of) in accordance with the requirements of MARPOL 73/78 and the regulations of the receiving port and the flag nationality of the seismic survey vessel. Under no circumstances will solid and scheduled wastes be disposed of to the sea;
- The seismic survey vessel may have onboard incineration facilities. Resultant incineration residues would be returned to shore for disposal at an appropriate facility;
- Any scheduled wastes returned to shore will be stored, labelled and disposed of in accordance with local legislation.
- No scheduled waste will be disposed of to a facility that is not fully equipped to receive and store it;
- Material minimisation followed by the reuse and recycling of materials will be considered wherever possible;
- Accurate and detailed manifestation and documentation of all wastes generated, disposed of or transferred to shore will be maintained.

AIR EMISSIONS CONTROL

No impacts relating to emissions from survey operations on air quality are expected to occur, provided the following measures are followed:

- All vessel propulsion systems, exhaust systems, power generation equipment and waste incinerators are well-maintained and operated efficiently;
- No ozone depleting substances will be used, except in refrigeration equipment where closed recovery systems will be employed;

CONTROL OF ACCIDENTAL SPILLS, LEAKS & DROPPED OBJECTS

Accidental events including inter-vessel collisions, interactions with the survey equipment, vessel grounding, spills and leaks of hydrocarbon materials or waste products have the potential for adverse environmental consequences, unless they can be controlled. Survey activities will be conducted in accordance with the highest standards of safety and industry association guidelines for offshore seismic operations. Detailed written operational, contingency and response procedures, including Emergency Response Plans, will be in place onboard the vessels to cover all anticipated activities and hazard scenarios. Members of staff will be assigned to these procedures, including an Emergency Response Coordinator and crewmembers who are proficient in the use of clean-up equipment.

The survey contractor will prepare an emergency contingency plan, which will address the recommendations contained in this document. The following planned and recommended measures have been designed to reduce the risks and possible impacts of accidental events to ALARP levels.

- Survey activities will be conducted in accordance with the vessels' operating procedures including:
 - A health, safety and environment (HSE) management system incorporating all the key management components (policy, organisation and responsibilities, planning and implementation, performance monitoring, audits and inspections, review and improvement);
 - An operational plan for the survey operations;
 - An activity catalogue (itemizing key personnel tasks and responsibilities);
 - Hazard analysis (safety hazards register, safety-critical operational procedures and a manual of permitted operations).
- A support vessel will be provided to serve as advanced warning to other users of the marine environment, to protect deployed equipment and to assist / support the seismic survey vessel in the event of power failure, steering failure, crew evacuation *etc.*
- The seismic survey vessel will be installed with radar, navigation and communication systems.
- The minimum operational water depth will be 10 m, in order to protect the vessel and survey equipment from grounding and snagging risks. Provisions will be made to have vessel and equipment support in the field during operations to recover seismic array gear broken or lost during operations. All reasonable efforts will be made to effect recovery of gear.
- Survey operations will be suspended in severely adverse weather conditions.

- All petroleum products and hazardous substances will be stored according to US regulations and manufacturer's directions in approved containers, labelled correctly and stored in bunded areas where spills can be contained and treated.
- All hazardous materials will be identified and handled appropriately, and safety regulations and manufacturer's directions will be available to all crew members.
- The valves between fuel tanks with manifolds will normally be closed, and all fuel tanks or drums will be labelled with their contents.
- All portable tanks, drums, containers and equipment with capacities of 25 litres or more will be marked with the contractor's name.
- Oily wastes will be handled in accordance with *MARPOL 73/78* requirements.
- All pumping and filling equipment will be kept in good operational condition and will be checked regularly for leaks.
- If oil filled streamers are used, they will be filled with cable oil within a dedicated bunded filling area by trained operatives.
- The cable deck, storage and under streamer reel areas will be constructed to collect any spills. These areas will drain into a holding tank, and the contents will be recycled or sent ashore for recycling or disposal.
- All deployed equipment will be highly visible and labelled.
- Waste reception facilities on the vessels will be clearly labelled and containers/facilities used to store wastes onboard will be closed or covered to prevent accidental overboard loss.
- The streamers will be fitted with depth controllers to allow the rapid raising/ lowering of the streamers in the event of potential conflict.
- Any waste materials and equipment accidentally lost overboard will be recorded and recovered (whenever possible).
- Regulatory agencies and local traffic will be notified of the loss of equipment.
- Items will be attached securely to equipment, e.g. the securing of weights onto streamer cables and the use of tape to secure objects will be minimised.
- Inflatable devices on the streamer sections will prevent sections from being lost. The devices activate when the streamer section sinks to an unacceptable depth.
- Location devices will be in place on the deployed tail buoy and streamer to aid location and recovery in the event of a loss.

- All 'in-sea' equipment will be accounted for.
- Shipboard Oil Pollution Emergency Plans (SOPEP) requires that the vessels carry out an oil spill clean-up drill at intervals to be decided by the vessel owners. Drills should be carried out at least bi-weekly as a minimum measure.

If a spill occurs, response and contingency plans for accidental events will be in place including a SOPEP, associated equipment and an appropriate spill kit. The safety of personnel will be the primary concern. Any crewmembers involved in clean up or containment will have an adequate level of training and will wear Personal Protective Equipment (PPE) appropriate to the nature and volume of spilled material.

In addition:

- No smoking or open lights will be permitted near to the spill;
- Appropriate authorities will be notified immediately after the leak is detected or observed;
- Professional assistance will be requested if considered to be required by trained personnel;
- The location of the spill, prevailing winds, currents and sea state will be identified and recorded;
- Remedial actions to prevent further leakage will be employed where possible, e.g. the plugging of a hole, the transfer of spilling fluids on a breached tank or the listing/trimming of the vessel to bring an area of damage above the water line;
- Where possible, the spill will be contained through the downwind assembly of a containment boom, pump preparation and application of absorbent pads;
- No dispersants will be used unless appropriate authorities approve their use;
- Follow-up action will be taken to prevent recurrence.

Table 1 Comparison of recommendations of JNCC, HESS, Australian, and MMS Guidelines on Marine Mammal Monitoring and Mitigation.

Monitoring Type	Guidance	Recommended Y/N	Specific Comments
Seasonal Restrictions	JNCC	Y	Operators should plan surveys so that their timing will reduce the likelihood of encounters with marine mammals, although at present there is limited information on their distribution in some areas
	HESS	Y	The measures recommended are keyed to two major factors: 1) the seasonal occurrence and distribution of marine mammals believed to be most sensitive to the potential effects of seismic sound ..., and 2) the projected duration of proposed surveys.
	Australian	Y	The Australian guidelines distinguish some periods of the year and locations that are more 'sensitive' than others, based on the occurrence and aggregation of threatened species of cetaceans, especially if engaged in breeding, feeding, or migration.
	USMMS	N	The MMS guidelines for the Gulf of Mexico do not include any seasonal restrictions on seismic programs.
Aerial Surveys	JNCC	N	Recommendations and requirements for aerial monitoring are not included in guidance
	HESS	Y	All aerial surveys should be flown in a two-engine, fixed-wing aircraft. At a minimum, the survey crew should consist of two observers, one data recorder / observer, and a pilot (who also serves as an observer). Surveys should be flown at an altitude of 1000 (feet) ASL and a speed of 100 kts. Standard equipment should include a GPS navigational system tied to an onboard computer and an intercom system connecting all crewmembers. All observers should be certified by NMFS as marine mammal observers...

	Australian	Y	The Australian guidelines indicate that aerial surveys may be called for during seismic surveys in Habitat Categories B2, C, and D.	
			Two types of surveys are envisaged and the requirement for either or both will be assessed on a case-by-case basis.	
			ways to identify where cetaceans are in relation to seismic activity and to identify when seismic vessels should be especially vigilant. These surveys would be run between the areas to be surveyed by the seismic vessel and the likely approach direction of cetaceans, or in the area in advance of the survey vessel.	
			Scientific surveys to identify which areas are important to cetaceans e.g. to identify feeding, breeding and resting areas and times of peak migration. In particular these surveys may be required in areas of potential increased sensitivity where insufficient information currently exists to determine timing and appropriate management arrangements."	
			Recommendations and requirements for aerial monitoring are not included in guidance	
Airgun Array Size and Configuration Adjustment	USMMS	N	Operators should seek to reduce and/or baffle unnecessary high frequency noise produced by air-guns or other acoustic energy sources. Throughout the survey, the lowest practicable power levels should be used	
	JNCC	Y	HESS guidelines do not specifically call for minimising the size of the airgun array or its sound output. However, they do call for the survey proponent to specify the characteristics of the proposed array, its source level, and the distance out to which the sound level could exceed 180 dB re 1 µPa (ms).	
	HESS	Y	Australian guidelines do not include specific wording concerning the size or sound output of the airgun array. However, there is special concern about the zone around the sound source within which the sound level exceeds 150 dB re 1 µPa (ms), or 140 dB in the case of cetacean aggregation areas or critical habitats. Those areas will depend on the size and design of the airgun array.	
	Australian	Y	Guidance does not include recommendations concerning airgun array size and configuration	
	USMMS	N	Where equipment allows, power should be built up slowly from a low energy start-up (e.g. starting with the smallest air-gun in the array and gradually adding in others) over at least 20 minutes to give adequate time for marine mammals to leave the vicinity. There should be a soft start every time the airguns are used, even if no marine mammals have been seen. The soft start may only be waived for surveys where the seismic sources always remain at low power levels e.g. some site surveys	
Ramp Up or Soft Start	JNCC	Y	this has primarily been a common sense measure, since there have been no comprehensive studies of the effectiveness of ramp-up procedures	
	HESS	Y		

	Australian	Y	<p>Australian guidelines call for 'soft starts' during all seismic surveys, even in offshore waters outside known migratory paths and periods. Specifically, the guidelines state the following:</p> <ul style="list-style-type: none">• A sequential build-up of warning pulses will be carried out at the commencement of all surveys. The whole array will not be fired without a full soft start. Soft starts will be used even if no whales have been seen;• Visual observation will be maintained continuously during soft starts to establish the presence or absence of whales within 3 km of the vessel;• If whales are sighted during this soft start procedure within the 3 km zone, the seismic source will be shut down. Re-commencement of soft start procedures will take place after 30 minutes has lapsed since the last whale sighting within the 3 km zone;• There may be continued discharge of the acoustic source during line turns or changes. Discharge of only a limited number of airguns in the acoustic array would be sufficient in this case.
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	USMMS	Y	<p>MMS guidelines for the Gulf of Mexico require "soft start" procedures for all seismic surveys in water depths greater than 200 m and operations in OCS water depths less than 200 meters (656 ft.) in the Eastern Planning Area of the Gulf of Mexico. Specifically, the guidelines state the following monitoring requirements:</p> <ul style="list-style-type: none"> • <i>"Visually monitor the exclusion zone and adjacent waters for the absence of sperm whales for at least 30 minutes before initiating ramp-up procedures. If no sperm whales are detected, you may initiate ramp-up procedures. You must not initiate ramp-up procedures at night or when you cannot visually monitor the exclusion zone for sperm whales if your minimum source sound level output drops below 160 dB re 1 μPa (see measure 5).</i> • <i>Initiate ramp-up procedures by firing a single airgun. The preferred airgun to begin with should be the smallest airgun, in terms of energy output (dB) and volume (in³).</i> • <i>Continue ramp-up by activating additional airguns at a rate of 6 dB re 1 μPa per 5 minute interval until the airgun array is operating at the desired survey intensity.</i> • <i>Immediately shut down all airguns ceasing seismic operations at any time a sperm whale is detected entering or within the exclusion zone. You may recommence seismic operations and ramp-up of airguns only when the exclusion zone has been visually inspected for at least 30 minutes for the absence of sperm whales.</i> • <i>You may reduce the energy output of the airgun array to maintain a minimum source sound level output of 160 dB re 1 μPa for routine activities, such as making a turn between line transects, or for maintenance needs. This procedure may be followed during periods of impaired visibility (e.g., darkness, fog, high sea states, etc.) and does not require a 30 minute visual clearance of the exclusion zone before the airgun array is again ramped up to full output.</i>
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Safety Distance	JNCC	Y	<p>JNCC guidelines call for delaying the start of airgun operations when marine mammals are sighted (or detected acoustically) within 500 m of the vessel or survey equipment, but there is no wording calling for suspension of airgun operations when mammals are seen within any specified distance when the airguns are already operating:</p> <ul style="list-style-type: none"> • <i>"Beginning at least 30 minutes before commencement of any use of the seismic sources, the operator and observers should carefully make a visual check from a suitable high observation platform to see if there are any marine mammals within 500 metres, ..."</i> • <i>DELAY: If marine mammals are present, the start of the seismic sources should be delayed until they have moved away, allowing adequate time after the last sighting (at least 20 minutes) for the animals to move well out of range. Hydrophones may also be useful in determining when cetaceans have moved. In situations where seal(s) are congregating immediately around a platform, it is recommended that commencement of the seismic sources begins at least 500 m from the platform.</i>
	HESS	Y	Recommend modelling or sound source output to ascertain the distance to 180 and 160 dB isopleth
	Australian	Y	Australian guidelines call for the onset of airgun operations to be delayed if a whale is seen within 3 km of the vessel during the 90 minute period before operations are expected to begin. Airgun operations are also to be suspended if a whale is seen within 3 km during airgun operations.
	USMMS	Y	MMS guidelines for the Gulf of Mexico call for the onset of airgun operations to be delayed if a sperm whale is seen within a 500 m radius surrounding the centre of an airgun array and the area within the immediate vicinity of the survey vessel during the 30-minute period before operations are expected to commence. Airgun operations are also to be suspended if a sperm whale is seen within this exclusion zone during airgun operations.
Shipboard Marine Mammal Observers	JNCC	Y	<ul style="list-style-type: none"> • <i>In areas which are important for marine mammals (as indicated in consultation with the JNCC) operators should seek to provide the most appropriately qualified and experienced personnel to act as marine mammal observers on board the seismic survey vessel. If possible, such observers should be experienced cetacean biologists. As a minimum, it is recommended that observers should have attended an appropriate training course."</i> • <i>"If advised to do so by the JNCC, discuss the precautions which can be taken to reduce disturbance, and the design of any scientific studies with the Sea Mammal Research Unit... In areas where marine mammals are abundant, properly conducted observation and recordings using qualified observers (see above) carried out before, during and after the seismic survey, can provide valuable information on its effect.</i> • <i>LOOK AND LISTEN: Beginning at least 30 minutes before commencement of any use of the seismic sources, the operator and observers should carefully make a visual check from a suitable high observation platform to see if there are any marine mammals within 500 metres...</i>

	HESS	Y	<p>HESS guidelines include many details concerning the number and qualifications of observers, the types of equipment they should use, and whether operations should continue during the night or periods of poor visibility. Specific requirements depend on the duration of the seismic survey and the types and numbers of marine mammals likely to be encountered. As a minimum, two or three observers with experience as marine mammal observers are required, depending on the duration of the survey. One observer is to be on duty whenever the airgun array is operating, day or night, and beginning at least 30 minutes prior to 'soft start'. Individual watches should not last longer than 4 hours. Observers have the authority to require shutdown of the airguns whenever marine mammals are observed within a designated safety radius.</p>
	Australian	Y	<p>Australian guidelines also call for visual observations from the seismic survey vessel during all seismic surveys, even those in offshore waters outside known migratory paths and periods. Trained and dedicated cetacean observers are required during seismic surveys in habitats that are considered more sensitive (Habitat Categories B2, C, and D). The guidelines also state that as a minimum measure the following procedures should be followed adopted.</p> <ul style="list-style-type: none"> • "During daylight hours, visual checks (using binoculars from a suitable, high observation platform on the survey vessel) for the presence of whales will be undertaken before the commencement of operations." • "During night time operations, the use of Infra-Red (IR) or night-vision binoculars will be used to undertake visual checks before the commencement of operations." • "Observations will begin at least 90 minutes prior to use of any high-energy acoustic sources, with particular focus on a 3 kilometres radius around the survey vessel." • "Visual observations of 10 minute duration per hour will be carried out during seismic operations." • "During night time operations, Infra-Red (IR) or night-vision binoculars will be used for the hourly observations. Night time visual observations will also be of 10 min duration per hour." • "Where a whale of a species included in Attachment 1 is seen as part of the observation procedures, continual observations should occur until 2 hours have passed since the last observation of a cetacean of a species included in Attachment 1." • "All cetacean observations, whether within 3 km or not, should be documented and reported." • More stringent observational protocols may be required in circumstances where seismic surveys will occur in whale feeding, breeding and resting areas and migratory routes identified in the Australian guidelines.

	USMMS	Y	MMS guidelines for the Gulf of Mexico require that seismic operators use trained visual observers on all seismic vessels who have successfully completed a NOAA Fisheries approved training program. The guidelines clearly state that "seismic operators must shut down the array when instructed by an observer" but provide few details about observational protocols (e.g., the use of binoculars, maximum length of observation periods). Observers are not required to monitor when atmospheric conditions reduce visibility to zero or during hours of darkness (i.e. night). The guidelines state at least two protected species visual observers will be required on watch aboard seismic vessels at all times during daylight hours (dawn to dusk) when seismic operations are being conducted, unless conditions (fog, rain, darkness) make sea surface observations impossible (1) other than brief alerts to bridge personnel of maritime hazards, no additional duties may be assigned to the observer during his/her visual observation watch (2) no observer will be allowed more than 4 consecutive hours on watch as a visual observer, (3) a "break" time of no less than 2 hours must be allowed before an observer begins another visual monitoring watch rotation (break time means no assigned observational duties), and (4) no person (crew or third party) on watch as a visual observer will be assigned a combined watch schedule of more than 12 hours in a 24-hour period.).
Operations at Night and in	JNCC	N	The JNCC guidelines do not specify any limitations on seismic surveys during darkness or poor visibility, and say very little about the detection problems at those times.

<p>Poor Visibility</p>	<p>HESS</p>	<p>Y</p>	<p>The night-time/poor-visibility issue received much attention during development of the HESS guidelines. The HESS Team noted that:</p> <ul style="list-style-type: none"> • "operations at night involve a trade-off regarding the ability to visually detect animals in the study area and the advantages of achieving continuous operation.... Night operation requires a case-by-case evaluation. Factors to consider seasonally (hours of daylight, weather, migration patterns), priority of animals of concern, air quality, fishing impacts, and economics." • "When operating under conditions of reduced visibility due to adverse weather conditions, operations may continue unless, in the judgement of the shipboard observers, the safety zone cannot be adequately monitored and observed marine mammal densities have been high enough to warrant concern that an animal is likely to enter the safety zone. Observers have the authority to permit operations to resume or continue under reduced visibility conditions, based on periodic re-evaluation that takes into account the densities of observed marine mammals and variations in visibility allowing for intermittent monitoring of the safety zone." • "To strengthen the authority of observers to require shutdown, more specific guidance regarding shutdown criteria to be applied in any specific project should be specified by (NMFS) in the proposed authorization. Such project-specific criteria may include the probabilities that individuals of particular species may enter the safety zone." • "To address the ongoing concerns about the adequacy of existing equipment and its ability to monitor the safety zone at all times (night time and reduced visibility) efforts should be made to test and determine the efficacy of available state-of-the-art equipment..." • "... if information becomes available that demonstrates that marine mammals of concern will avoid the safety zone when the vessel is shooting steadily, or that ramp-up methods are effective in moving marine mammals of concern away from the safety zone, it may be possible to remove the conditional requirements that an array be shut down at times of reduced visibility." <p>In the Australian guidelines, no shutdown requirements are specified for night or poor-visibility situations. For all seismic surveys:</p> <ul style="list-style-type: none"> • "During night time operations, the use of Infra-Red (IR) or night-vision binoculars will be used to undertake visual checks before the commencement of operations." • "During night time operations, Infra-Red (IR) or night-vision binoculars will be used for the hourly observations. Night time visual observations will also be of 10 min duration per hour."
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	Australian	Y	<p>Australian guidelines, no shutdown requirements are specified for night or poor-visibility situations. For all seismic surveys:</p> <ul style="list-style-type: none">• <i>During night time operations, the use of Infra-Red (IR) or night-vision binoculars will be used to undertake visual checks before the commencement of operations.</i>• <i>During night time operations, Infra-Red (IR) or night-vision binoculars will be used for the hourly observations. Night time visual observations will also be of 10 min duration per hour.</i>
	USMMS	Y	<p>The MMS guidelines for the Gulf of Mexico do not require monitoring when atmospheric conditions reduce visibility to zero or during the night. However, the guidelines prevent initiation of 'soft start' procedures at night or when poor visibility prevents visual monitoring of the exclusion zone for sperm whales if the minimum source sound level output drops below 160 dB re 1 μPa. The MMS NTL states Monitoring for whales with a passive acoustic array by an observer proficient in its use will allow ramp-up and the subsequent start of a seismic survey during times of reduced visibility (darkness, fog, rain, etc.) when such ramp-up otherwise would not be permitted using only visual observers</p>

Table 2 Summary of Potential and Residual Impacts (Taking Agreed Mitigation Measures into Account)

Issue	Key Impacts	Potential Impact	Residual Impact
Noise and Disturbance Effects on Marine Biota			
The effects of noise and physical presence of survey vessels on marine mammals	• TTS, PTS, and non-auditory physiological effects on all cetaceans and pinnipeds	Moderate	Minor
	• Disturbance and short-range avoidance movements in bowhead whales and seals	No Impact	No Impact
	• Deflection from usual migration route of bowhead whales migrating through the area of seismic acquisition	Moderate	Moderate
	• Reduced feeding opportunities, possible loss of reproductive potential, reduced growth, and reduced ability to survive winter for marine mammals	Moderate	No Impact
	• Injury or fatality to marine mammals from collisions with vessels and deployed equipment	Moderate	Minor
The effects of physical presence of survey vessels and seismic sound sources on other marine biota	• Injury and fatality from underwater airgun noise	Minor	Minor
	• Spawning disturbance or damage to eggs	No Impact	No Impact
	• Behavioural disturbance e.g. dispersal of fish shoals	Minor	Minor
	• Noise and disturbance impacts to birds (including secondary impacts due to the disturbance of prey species)	No Impact	No Impact

Impacts on Other Users of the Area

Vessel and equipment interaction with other users of area	• Potential for collision or other accident with other vessels, equipment and associated injury, loss of life, vessel damage, loss of property/cargo	Moderate	Minor
	• Interference with any military use of the area	No Impact	No Impact
	• Direct damage to identified or unidentified wreck or non-wreck sites	No Impact	No Impact
	• Hunting of marine mammals and birds	Major	Moderate
	• Impacts on the local social environment and economy	Moderate	Moderate
	• Impacts on cables and other manmade submarine infrastructure	No Impact	No Impact

Pollution Impacts from Effluents, Emissions and Wastes

Effluent discharges	• Impacts on water quality and marine biota from cooling water and surface drainage discharges (e.g. sea spray and rainwater)	No Impact	No Impact
	• Impacts on water quality and marine biota from controlled drainage and sanitary waste water discharges	Minor	Minor
	• Impacts on marine biota from water intakes	Minor	Minor
Air emissions from	• Reduction in local air quality	Minor	Minor

survey vessels	<ul style="list-style-type: none">• Contribution to regional and global atmospheric pollution phenomena e.g. acidic deposition, ozone layer depletion and the greenhouse effect	Minor	Minor
Solid and scheduled waste	<ul style="list-style-type: none">• Impacts on marine organisms from waste management and disposal practices	Moderate	No Impact
Accidental Spills, Leaks and Dropped Objects			
Spills, leaks and dropped objects	<ul style="list-style-type: none">• Small release of harmful substances (e.g. wastes, oil, fuel oil) resulting in a decrease in water quality and injury to marine organisms	Minor	No Impact
	<ul style="list-style-type: none">• Loss of small objects and cargo	Moderate	Minor
	<ul style="list-style-type: none">• Large release of harmful substances (e.g. wastes, oil, fuel oil), and large scale objects and cargo resulting in a decrease in water quality, injury to marine organisms and obstruction to other vessels		